WHAT WE CLAIM ARE:

1. A-semiconductor device comprising:

a semiconductor substrate;

a gate insulating film made of silicon oxynitride and disposed on a partial surface area of the semiconductor substrate;

a gate electrode disposed on the gate insulating film; and

source and drain regions disposed on both sides of the gate electrode,

wherein an existence ratio of subject nitrogen atoms to a total number of nitrogen atoms in the gate insulating film is 20 % or smaller and wherein three bonds of each subject nitrogen atom are all coupled to silicon atoms and remaining three bonds of each of three silicon atoms connected to the subject nitrogen atom are all coupled to other nitrogen atoms.

2. A semiconductor device according to claim 1, wherein a thickness of the gate insulating film is 3 nm or thinner.

3. A semiconductor device comprising:

a semiconductor substrate;

a gate insulating film disposed on a partial surface area of the semiconductor substrate, the gate insulating film being a lamination of a silicon oxynitride film and a high dielectric constant film disposed in an order recited, the high dielectric constant film having a higher dielectric constant than a dielectric constant of the silicon oxynitride film;

a gate electrode disposed on the gate insulating film; and

source and drain regions disposed on both sides of the gate electrode,

wherein an existence ratio of subject nitrogen atoms to a total number of nitrogen atoms in the silicon oxynitride film is 20 % or smaller and wherein three bonds of each subject nitrogen atom are all coupled to silicon atoms and remaining three bonds of each of three silicon atoms connected to the subject nitrogen atom are all coupled to other nitrogen atoms.

4. A method of manufacturing a semiconductor device, comprising steps of:

forming a silicon oxynitride film on a surface of a semiconductor substrate;

forming a conductive film for a gate electrode on the silicon oxynitride film;

patterning the conductive film to leave a gate electrode; and

implanting impurities into semiconductor regions on both sides of the gate electrode to form source and drain regions,

wherein in the step of forming the silicon oxynitride film, the silicon oxynitride film is formed under the conditions that an existence ratio of subject nitrogen atoms to a total number of nitrogen atoms in the silicon oxynitride film becomes 20 % or smaller and wherein three bonds of each subject nitrogen atom are all coupled to silicon atoms and remaining three bonds of each of three silicon atoms connected to the subject nitrogen atom are all coupled to other nitrogen atoms.

5. A method of manufacturing a semiconductor device according to claim 4,

wherein the step of forming the silicon oxynitride film comprises steps of:

forming a silicon oxide film on the surface of the semiconductor substrate; and

nitriding the silicon oxide film.

6. A method of manufacturing a semiconductor device according to claim 4, wherein the step of forming the silicon oxynitride film comprises steps of:

forming a silicon nitride film on the surface of the semiconductor substrate; and

oxidizing the silicon nitride film.

7. A method of evaluating the characteristics of a semiconductor device, comprising steps of:

forming a silicon oxynitride film on a surface of a semiconductor substrate;

measuring an existence ratio of subject nitrogen atoms to a total number of nitrogen atoms in the silicon oxynitride film, wherein three bonds of each subject nitrogen atom are all coupled to silicon atoms and remaining three bonds of each of three silicon atoms connected to the subject nitrogen atom are all coupled to other nitrogen atoms; and

evaluating characteristics of a MISFET using the silicon oxynitride film as a gate insulating film, in accordance with the measured existence ratio.

8. A method of evaluating the characteristics of a semiconductor device, comprising steps of:

forming a silicon oxynitride film on a surface of a semiconductor substrate;

measuring an energy spectrum of electrons on 1s orbital of nitrogen atoms in the silicon oxynitride film by using X-ray photoelectron spectroscopy;

separating a peak obtained by X-ray photoelectron spectroscopy into at least two first peaks on a higher energy side than an energy of electrons on 1s orbital of nitrogen atoms in silicon nitride and one second peak on a lower energy side than at least two peaks;

calculating a ratio of an area of the second peak to a total area of at least two first peaks and the second peak; and

evaluating characteristics of a MISFET using the silicon oxynitride film as a gate insulating film, in accordance with the calculated ratio.

9. A process condition evaluating method comprising steps of:

forming a silicon oxynitride film on a surface of a semiconductor substrate;

measuring an existence ratio of subject nitrogen atoms to a total number of nitrogen atoms in the silicon oxynitride film, wherein three bonds of each subject nitrogen atom are all coupled to silicon atoms and remaining three bonds of each of three silicon atoms connected to the subject nitrogen atom are all coupled to other nitrogen atoms; and

judging adequacy of a process condition of the step of forming the silicon oxynitride film in accordance with the measured existence ratio.

10. A process condition evaluating method comprising steps of:

forming a silicon oxynitride film on a surface of a semiconductor substrate;

measuring an energy spectrum of electrons on 1s orbital of nitrogen atoms in the silicon oxynitride film by using X-ray photoelectron spectroscopy;

separating a peak obtained by X-ray photoelectron spectroscopy into at least two first peaks on a higher energy side than an energy of electrons on 1s orbital of nitrogen atoms in silicon nitride and one second peak on a lower energy side than at least two peaks;

calculating a ratio of an area of the second peak to a total area of at least two first peaks and the second peak; and

judging adequacy of the step of forming the silicon oxynitride film in accordance with the calculated ratio.

11. A semiconductor device comprising:

a semiconductor substrate;

a gate insulating film made of silicon oxynitride and disposed on a partial surface area of the semiconductor substrate;

a gate electrode disposed on the gate insulating film; and

source and drain regions disposed on both sides of the gate electrode,

wherein an energy spectrum of electrons on 1s orbital of nitrogen atoms in the gate insulating film is measured by using X-ray photoelectron spectroscopy; and a peak obtained by X-ray photoelectron spectroscopy is separated into at least two first peaks on a higher energy side than an energy of electrons on 1s orbital of nitrogen atoms in silicon nitride and one second peak

on a lower energy side than at least two first peaks, wherein a ratio of an area of the second peak to a total area of at least two first peaks and the second peak is 20 % or smaller.

12. A semiconductor device according to claim 11, wherein a thickness of the gate insulating film is 3 nm or thinner.

13. A semiconductor device comprising:

a semiconductor substrate;

a gate insulating film made of a lamination of a silicon oxynitride film and a high dielectric constant film disposed in an order recited on a partial surface area of the semiconductor substrate, the high dielectric constant film having a dielectric constant higher than a dielectric constant of the silicon oxynitride film;

a gate electrode disposed on the gate insulating film; and

source and drain regions disposed on both sides of the gate electrode,

wherein an energy spectrum of electrons on 1s orbital of nitrogen atoms in the gate insulating film is measured by using X-ray photoelectron spectroscopy; and a peak obtained by X-ray photoelectron spectroscopy is separated into at least two first peaks on a higher energy side than an energy of electrons on 1s orbital of nitrogen atoms in silicon nitride and one second peak on a lower energy side than at least two first peaks, wherein a ratio of an area of the second peak to a total area of at least two first peaks and the second peak is 20 % or smaller.